Alternative Beneficiation When Conventional Approaches Can Not Be Justified

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SUMMARY

Many flyash beneficiation process concepts have been explored or are in development. Most focus on reducing the effects of carbon in flyash. Many different beneficiation methods have been identified, either as commercial processes, advanced development technologies, or emerging concepts. One, or some combination of these methods, might be customized and implemented in a cost-effective manner to meet the beneficiation needs of flyash producers.

But where does a flyash producer begin when trying to select the best process to apply? This paper describes two flyash production situations and several helpful steps to identify promising beneficiation approaches. It does not attempt to identify beneficiation methods that will solve all flyash problems. It identifies two possible beneficiation processes that could be effective and low cost for some flyash producers. It also gives examples of expected results from these non-commercial approaches.

Production Situations

Coal Fired Station #1:

- Relatively large flyash producer (over 250,000 tons/year)
- Potential placement of flyash in concrete market twice as large as regional flyash production

<	On-site disposal closing in two years
<	Tipping fees high at existing off-site landfill
<	Off-site landfill closing in five years - New off-site landfill cost projections expected to double
<	Fuel cost is high
<	Flyash is collected dry
<	Moderately fine flyash
<	Distinct carbon/mineral particle size distributions
<	Good pozzolanic activity
<	Moderate LOI - Single digits to low teens

<u>Coal Fired Station #2:</u>
<	Moderate flyash production (less than 100,000 tons/year)
<	Concrete market placement is possible but another, larger, flyash producer is already established in the area
<	No on-site landfill, no room to build
<	Tipping and transportation fees very high
<	Fuel cost is high
<	Flyash is collected dry
<	Very fine flyash
<	Similar carbon/mineral particle size distribution
<	Very high LOI - over 20% consistently

Selecting the best processing technology is complex. There are a number of factors to consider and balance. Some of these factors are economic and some are physical. The following steps are recommended to identify promising beneficiation processes:

1. **Define the Market Drivers** (fuel costs, landfill costs, revenue opportunities)
2. **Identify Potential Beneficiation Processes**
3. **Analyze Flyash Characteristics** (LOI, size distributions, mineral constituents, resistivity, densities, combustion reactivity)
4. **Select a Beneficiation Process** that meets the Market Drivers considering the Flyash Characteristics

<u>Selection Steps for Coal Fired Station #1</u>:

1. Market Drivers - Fuel cost is high, landfill costs are high, and revenue opportunities are good. The economics appear to allow for a fully commercial process. Early application assists both economic benefits and corporate goals to recycle flyash.
2. Potential Beneficiation Processes - Passivation won't solve this problem. Wet processes add energy costs that might be avoided in this case. Commercial External Burnout and Dry Separation processes appear to be candidates.
3. Flyash Characteristics - Pozzolanic reactivity is good so placement in the concrete market appears attractive. The flyash comes from many different coal sources so carbon LOI and combustion

reactivity is widely variable. Flyash resistivity is good enough for electrostatic processing.

4. Select a Process - Widely varying LOI and carbon reactivity may make combustion processes more difficult to apply than in some cases. Flyash testing with commercial electrostatic and combustion processes are warranted.

Selection Steps for Coal Fired Station #2:

1. Market Drivers - Fuel cost is high and landfill costs are high, but revenue opportunities are limited. Initial market surveys indicate that placement of flyash in flowable fill is possible. Flowable fill may be the only market product at present that can absorb flyash in necessary quantities. Economic evaluation suggests that some beneficiation is cost-effective but it does not appear to allow for a fully commercial, stand-alone facility.
2. Potential Beneficiation Processes - Passivation won't solve this LOI problem. Wet processes add energy costs that might be avoided in this case. Station property is very limited for any new processing facility. Simplified combustion and dry separation processes appear to be promising if they can be physically integrated into existing facilities.
3. Flyash Characteristics - The flyash comes from relatively few different coal sources. Most of these coals are low-ash coals, so flyash LOI is high. Flyash resistivity is adequate but high carbon content suggests that electrostatic charging may dissipate rapidly. Carbon combustion reactivity is good. Carbon and mineral particle size distributions suggest that aerodynamic separation may not be as effective as in some cases. The particle size distributions also suggest that finer flyash fractions may have lower LOI than the bulk flyash.
4. Select a Process - Present coals have a much lower ash content than the design coal for the precipitators. Since carbon reactivity is good, reinjection of flyash may reduce bulk LOI without overloading the precipitator. Also, the size distributions of carbon and mineral suggest that some LOI reduction may be possible through mechanical sieving. Testing this flyash with sieving and reinjection processes seems warranted.

"Partial Solutions"

A number of potential markets and products have been identified for flyash placement. A key requirement for any market or product is that it can absorb sufficient quantities of flyash to solve the recycling goals of the flyash producer. Concrete is such a product in many areas of the United States. Locations where there is an active construction industry can often absorb large quantities of flyash in cast-in-place concrete. This market normally offers good financial incentive for flyash but it requires quite stringent LOI parameters. Other products and markets have been identified, but they do not usually offer a comparable financial return for flyash, nor are they as widespread. Consequently, their market value can often only support lesser cost beneficiation solutions.

Fortunately some of these lesser-value products require less strict LOI control of the flyash, such as waste stabilization/remediation, cement kiln feed, flowable fill, and cellular concrete block. So these products may only require removal of part of the carbon from flyash to meet product requirements. This requirement for partial removal of carbon from flyash may allows application of “partial solution” technologies, that is, processes that would not beneficiate flyash sufficiently for concrete specifications but which are adequate for lesser-value flyash products. Two such “partial solutions” may be flyash reinjection and sieving.

Injecting flyash into an operating furnace allows most of the carbon in reinjected ash to burn out in the furnace. The remaining reinjected mineral matter mixes with newly created flyash. This added mineral increases the total mineral quantity coming out of the furnace and dilutes the carbon-to-mineral ratio. Based on field testing and calculations, LOI reduction can be significant, especially with generating units which are presently burning a coal of a lower ash content than the precipitator was designed to accommodate. For example, it was shown in one case that by reinjecting high LOI flyash into a boiler, the bulk LOI could be reduced by about five percentage points, making it suitable for a lesser-value product.

Sieving flyash capitalizes on the tendency of carbon and mineral to have different particle size distributions within flyash. Carbon and mineral particle size distributions can be widely different, but even in those flyashes which show similar carbon and mineral distributions, there appears to be a clear trend. Typically, flyashes sieved through a 325 mesh screen exhibits a measurable reduction in LOI. For example, in one case, it was shown that sieving the station’s flyash could reduce the LOI by ten percentage points.

It would be possible to combine these two LOI reduction methods for further advantage. By first sieving the flyash and then reinjecting the flyash retained on 325 mesh and above, greater LOI reduction could be gained than either method alone. The flyash injected into the furnace would have a higher LOI than the bulk ash, combusting even more of the unburned carbon. Some of the mineral matter generated would be cycled through a processing loop, but all mineral matter would eventually leave the station as a recycled produc.